Environment Canada Environnement

Wildlife Toxicology Fund annual report to the
Minister of the Environment
Date: 1989/90

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WILDLIFE TOXICOLOGY FUND

REPORT 1989/1990

Environment Canada
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WWF World Wildlife Fund
Fonds Mondial pour la Nature

WILDLIFE TOXICOLOGY FUND

REPORT 1989/1990

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WILDLIFE TOXICOLOGY FUND

REPORT 1989/1990

BACKGROUND

The Wildlife Toxicology Fund (WTF) is a co-operative grant program initiated in 1985 by Canadian Wildlife Service of Environment Canada and World Wildlife Fund Canada. The program is designed "to provide high quality scientific information that can be directly applied to the protection of wildlife in Canada from irreversible harm caused by toxic chemicals in the environment." In addition, the WTF is intended "to enhance and develop private sector expertise, and to act as a stimulus for the joint funding of research projects." To this end, the grant program operates on a matching fund basis, with 50% of the funds coming from sources other than the WTF.

The first phase of the program ran from 1985 - 1988. A total of 53 projects were funded during the first phase of the WTF. The WTF contributed a total of $2,307,446 for these projects which was matched by $3,626,094 in funding from outside sources. All administrative costs for the program were covered by annual grants from Noranda Inc.

This initial set of projects covered a wide range of concerns in the field of wildlife toxicology. The effects of Great Lakes contamination was a major focus. Researchers at the University of Toronto, the University of Windsor, Brock University and the University of Guelph were all involved in WTF projects which examined the impact of Great Lakes contaminants on fish, birds and turtles in the region.

Prairie pesticide use and its effects on wildlife was the concern of a number of projects undertaken by researchers from the prairie provinces. The grasshopper spray, carbofuran, was a major focus. Two forest herbicides - glyphosate and hexazinone - and their impacts on small mammals and bird species were examined in separate projects in Nova Scotia and in Alberta. The issues of heavy metals in the environment, the impact of acid rain, marine pollution and the contamination of Arctic wildlife were also dealt with through WTF-funded research.

Results from many of these projects are now available. A full list of projects is attached (Appendix A) as well as a list of final reports which are available upon request from World Wildlife Fund (Appendix B).

MANDATE OF WILDLIFE TOXICOLOGY FUND 1988 - 1991

The WTF was renewed in August 1988 with a second three-year mandate. According to the Memorandum of Understanding between WWF and Environment Canada, the federal government is providing $1 million over three years to support the activities of the WTF, provided WWF raises an additional $600,000 over the three years from other sources. Since the renewal of the program in 1988, the Natural Sciences and Engineering Research Council has joined Environment Canada in meeting the $1 million federal commitment to the WTF.

World Wildlife Fund is administering the program by appointing with Environment Canada a Research Advisory Board to receive and evaluate all proposals; by providing all application forms, brochures, announcements, etc.; and by monitoring project progress and results in close co-operation with Environment Canada. Noranda Inc. continues to cover the administrative costs of the WTF, contributing $124,550 for the period 1988-1991.

The current funding guidelines for the WTF call for research proposals which will produce information useful to:

1. **Assessment of substances on the Priority Substances List of the Canadian Environm ental Protection Act and corresponding Acts of participating Provincial Governments.**

2. **Pesticides, both chemical and microbial, on the Department of Environment's priority list for review under the Pest Control Products Act or equivalent priorities identified by participating provincial Governments.**

3. **Topics of concern identified by the Canadian Wildlife Service component of the inter-departmental Long Range Transport of Airborne Pollutants Program.**

Further details on the specific criteria within each of these categories is contained in **Wildlife Toxicology Fund - Information for Applicants**. These application guidelines, which are available in both English and French, have been distributed to all universities across the country (Appendix B).

RESEARCH ADVISORY BOARD

The Research Advisory Board of the Wildlife Toxicology Fund is made up of some of Canada's foremost experts in the field of wildlife toxicology. Dr. Donald A. Chant, Chairperson of the Ontario Waste Management Corporation, serves as Chairperson of the Research Advisory Board. A list of the Board members is attached (Appendix C).

The Research Advisory Board evaluates proposals on a monthly basis. Proposals are circulated to the Board by mail. Evaluations are returned to WWF. On the basis of the evaluations, Dr. Chant recommends approval or refusal of the individual grant applications. In addition, the Board meets annually to review the operations of the WTF.

PROJECTS SPONSORED 1988 TO PRESENT

During the current phase of the Wildlife Toxicology Fund, 34 projects worth a total value of $4,034,150 have been funded. This represents a contribution of $1,518,382 from the Wildlife Toxicology Fund which has been matched by outside sources in the amount of $2,515,768. A list of these projects is appended (Appendix D) and a brief description of each project is included (Appendix A).

WTF-funded projects cover a broad range of wildlife toxicology concerns:

a) Acid Rain

The impact of acid rain on wildlife is addressed in eight of the projects (Projects #1, 6, 7, 9, 10, 11, 28 and 31). Researchers in Ontario, Quebec and Nova Scotia have received funding to analyze the effects of acid rain on a variety of wildlife including: fish, songbirds, trees, waterfowl, loons and clams.

b) Pesticides

Pesticides and their effects on Canadian wildlife is the focus of 11 of the projects. (Projects #2, 5, 12, 14, 15, 16, 20, 21, 30, 32 and 34). A number of the projects are concerned with the impact of carbofuran, a grasshopper spray, on prairie wildlife. The pesticide has been shown to have very harmful effects on waterfowl and Burrowing Owls, as threatened species in Canada. Information acquired through the WTF projects is being used by the Canadian Wildlife Service and WWF in building a case for the de-registration of the pesticide in Canada.

Other pesticides under study include dicofol, hexazinone herbicide, and pyrethroid pesticides. One researcher is also looking at the impact of the microbial pesticide *Bacillus thuringensis* on the chicks of Spruce Grouse.

c) Pulp Mill Effluent

Another important category of projects are those dealing with the effect of pulp mill effluent on wildlife. Three researchers at the University of British Columbia and a fourth at the University of Victoria are examining the impact of dioxins, produced by the chlorine bleaching process used in many pulp mills, on wildlife — specifically Great Blue Herons, clams and marine bottom fish. Research supported by the WTF and the Canadian Wildlife Service provided valuable background for the submission prepared by Environment Canada and the Department of Fisheries and Oceans at the recent hearings on the proposal by Alberta-Pacific Forest Industries to construct a bleached kraft pulp mill in northern Alberta.

d) Great Lakes - St. Lawrence

Contamination of the Great Lakes and St. Lawrence ecosystem was a focus of many of the projects funded during the first phase of the WTF. This concern continues in the second phase (See Projects #4, 8 and 17). Of special note is the pioneering work being undertaken by Dr. Pierre Beland, of the St. Lawrence National Institute of Ecotoxicology, on the toxicology and pathology of St. Lawrence marine mammals. High levels of toxic chemicals in Beluga Whales have been shown to correspond with a high incidence of various diseases, many of which are known to be induced by these compounds in experimental studies of other vertebrates. In addition to the WTF, Dr. Beland's research has been supported by the Department of Fisheries and Oceans, Alcan Aluminum Ltd., the Quebec Wildlife Foundation, Greenpeace and the Quebec Ministry

of the Environment.

e) Other projects

In addition to the aforementioned, the current roster of projects also examines the effects of heavy metal contaminants on Canadian wildlife (See Projects #3, 22, 23 and 27); the impact of hydrocarbons and organochlorine pollutants on shorebirds in Nova Scotia, and the effects of lead shot on waterfowl in the Maritimes (Projects #26 and 19).

MAKING A DIFFERENCE: THE IMPACT OF THE WILDLIFE TOXICOLOGY FUND

Since its inception, the Wildlife Toxicology Fund has sought to ensure that all projects funded are of a practical, applied nature and that the results produced are useful in addressing the key wildlife toxicology concerns confronting Canada.

Policy relevance is one measure of the utility of work funded by the WTF. During the past five years, there has been a number of examples of WTF projects which are contributing to the development of policies for the management of toxic chemicals. The impact of these projects are being felt in the following areas:

a) Pesticide Re-evaluation

Work by Dr. David Bird, of McGill University, on the effects of dicofol on kestrels, has shown that the pesticide causes avian embryonic mortality and eggshell thinning. These results have been instrumental in causing the U.S. Environmental Protection Agency to halt further sales of dicofol until a version having no impact on embryonic mortality or eggshell thinning is produced. Canada's assessment of dicofol is being influenced by EPA's decision.

The impact of carbofuran on Canadian wildlife is being addressed by researchers at the University of Guelph, the University of Manitoba, the University of Saskatchewan, and the Delta Waterfowl Research Station. Results from these projects are now being channelled into hearings that are underway to re-evaluate the registration of the pesticide in Canada.

b) Impact of Pulp and Paper Effluent

Projects by Dr. Gail Bellward, Dr. John Steeves and Dr. Kim Cheng, of U.B.C., as well as a project undertaken by Dr. R. Reid, of the University of Victoria, are all providing information of direct relevance to the development of environmental guidelines for pulp and paper mills.

c) Great Lakes Contamination

Work by Dr. Adele Crowder, of Queen's University, on contaminants in Lake Ontario's Bay of Quinte wetlands, has been passed on to the Remedial Action Plan Committee for the area. The direct injection of WTF results into the process for addressing degradation in the lakes is a good model of the way in which research results can be used.

d) Additional Impacts

Apart from policy impact, WTF research has played a role in addressing toxicology concerns at specific sites. Work by Dr. Michael Dickman, of Brock University, identified a link between fish kills and the "shock-loading" of effluent into Ontario's Welland River. Dr. Dickman worked with Atlas Steels Ltd. to curb the effluent flow.

Through WTF funded research, Dr. Jack Klaverkamp of the University of Manitoba has been able to conclude that metal pollution controls installed at a smelter in Flin Flon, Manitoba in 1982 have not been effective in reducing pollution in nearby lakes. An upcoming book The Ecotoxicology of Metals: New Concepts and Applications will assist in publicizing this finding.

The development of new techniques is another measure of the utility of WTF-funded research. Examples include: 1) the development by Dr. Dickman, of Brock University, of a novel instrument for gathering samples of effluent discharged to a body of water during shock-loading events and the development of a reliable mutagenicity test for analyzing sediment chromotoxicity; 2) Dr. Philip Spear, of the University of Quebec, has developed a mechanism for monitoring dioxin in wildlife by using Vitamin A levels; 3) Dr. Ted Leighton, of the University of Saskatchewan, is evaluating a new method for diagnosing poisoning by organophosphate and carbamate pesticides.

Additional benefits of WTF-funded research projects can be cited. Dr. Barrie Webster, of the University of Manitoba, notes that WTF support for his project on the impact of carbofuran on ducklings has induced the University of Manitoba to devote more resources to toxicology research. Dr. Bob Ackman, of the Technical University of Nova Scotia, notes that WTF support for work on the impact of contaminants on shorebirds in the Maritimes has been extremely useful, because its national mandate is not restricted by the geographical constraints of provincial funding guidelines. The training of new graduate students in the field of wildlife toxicology is an additional benefit of WTF funding which has been noted by a number of WTF project co-ordinators.

CATALYZING NEW FUNDS FOR WILDLIFE TOXICOLOGY RESEARCH

Through the matching funds requirement for individual projects, the WTF has secured financial commitments from a number of outside funders for wildlife toxicology research. The sources are diverse and include corporations, provincial governments, federal departments and universities. A full list is attached (Appendix E).

This catalytic nature of the fund is, in the view of WWF, one of the strengths of the WTF. By bringing new funders to the issue, scarce funds have been enhanced and the result has been an excellent slate of research projects.

WWF has been proud to meet its funding obligations during the three years of the second phase of the WTF. A total of $618,425 has been raised and added to the $1 million commitment of Environment Canada and NSERC. WWF gratefully acknowledges the support of the following corporations and governments agencies for their generous support of the Wildlife Toxicology Fund: Inco Ltd., ($150,000 over three years); Ontario Ministry of the Environment ($150,000 over

three years); Quebec Ministry of the Environment ($75,000 over three years); Ontario Hydro ($8,000 over two years); Alcan Aluminum Ltd; ($86,425 over three years); Department of Fisheries and Oceans ($80,000 over three years); Northern Reflections Ltd ($44,000 over two years); the Quebec Wildlife Foundation ($25,000 over two years); and Greenpeace ($5,000).

WWF also acknowledges the very generous support of Noranda Inc. in meeting all the administrative costs of the WTF each year since 1985. This support has been extremely important to the successful and efficient operation of the WTF. It has also ensured that all other contributions to the WTF are channelled directly to research, with no hold-backs for overhead expenses. In 1990, Noranda also contributed $3,000 to help cover the costs of a project being undertaken by Dr. Patrick Weatherhead of Carleton University titled "Effects of Acidic Precipitation on Waterfowl: Reproductive Effort of Common Goldeneyes in High and Low Quality Habitats."

DISSEMINATION OF RESULTS

A full list of available WTF final reports is produced and circulated every six months. Reports are delivered to interested individuals upon request.

Each year, the WTF holds a seminar and invites presentations from selected project co-ordinators. The seminar was held in Montreal at Macdonald College in November 1989 on the occasion of the annual meeting of the Research Advisory Board. Ten project co-ordinators participated. A number of students and faculty of Macdonald College also attended the seminar.

The next seminar will be held in Saskatoon on December 12, 1990. The focus will be on WTF's research on the pesticide, carbofuran. In addition to WTF Project Co-ordinators, researchers from the Canadian Wildlife Service and the Saskatchewan Government have also been asked to participate. Non-governmental organizations with a particular interest in the carbofuran issue have also been invited. Given that the pesticide is under re-evaluation, the seminar will provide a timely overview of carbofuran's impact on Canadian wildlife.

During the past year, WWF has worked with the Canadian Wildlife Service to make carbofuran users aware of the pesticide's effects on wildlife. This process will continue during the coming year.

EVALUATION OF WTF ACTIVITIES

The current phase of the WTF will end on March 31, 1990. In order to be in a position to recommend future directions for the WTF, WWF and Environment Canada have agreed to undertake an evaluation of the activities of the WTF. The evaluation will address a number of issues including: the calibre of the research funded; the catalytic effect of the WTF; and the policy relevance of the work funded. The evaluation will be conducted by an independent researcher and will be made available to the federal Minister of the Environment upon its completion. The work is expected to be completed by the end of December 1990.

APPENDIX A

WTF-FUNDED RESEARCH PROJECTS 1988 - 1991

1. "Metabolic Consequences of Environmental Acidification"

Co-ordinator:

Dr. Steve F. Perry
Dept. of Biology
University of Ottawa

Description:

Dr. Perry and his research team are exploring whether the stressful nature of external acidification on fish induces metabolic re-partitioning such that internal energy resources are re-directed toward maintenance at the expense of growth and reproduction. The researchers are testing the hypothesis that the mobilization of the "glucocorticoid" steroid, cortisol, and of the catecholamines, namely norepinephrine and epinephrine, during exposure to an acidified environment promotes energetic re-partitioning of metabolism that ultimately limits growth in relevant fish species. Dr. Perry's research utilizes two important fish species known to inhabit acidified waters, brook trout and lake trout.

The study is intended to: 1) establish the mechanisms that cause reduced growth in chronically acid-exposed fish presented with abundant food; and 2) provide fisheries managers with sensitive biochemical indicators to assess the impact of sub-lethal acidification on natural fish populations. The majority of the evidence which the researchers have accumulated to date tends to suggest that cortisol does not act as a glucocorticoid in trout. There is, however, some indication that cortisol does exert some influence on the metabolism of these animals, namely significant elevated plasma amino acid levels, increased oxidation of alanine and increased synthesis of hepatocyte glycogen.

In a broader sense, it is expected that the research will provide wildlife managers with an understanding of the decline of Fish eating waterfowl communities (e.g. loons, ospreys, herons, eagles and kingfishers) inhabiting moderately acidified wetland ecosystems in which fish are still abundant.

Funding:

The WTF approved a grant of $73,200 for this project. A portion of this contribution comes from funds allocated by the Ontario Ministry of the Environment.

Matching Funds:

The Ontario Ministry of Natural Resources and the Natural Sciences and Engineering Research Council provided the matching funds for the project.

2. "Effects of Dicofol on Kestrels"

Co-ordinator:

Dr. David M. Bird
Macdonald College Raptor Research Centre
McGill University

Description:

Dr. Bird, in cooperation with Dr. Michael Fry and co-workers at the University of California at Davis, are investigating the eggshell-thinning effects of the pesticide dicofol and its potential for causing second generation abnormalities in the American Kestrel.

This study includes monitoring of reproductive functions in both first and second generation Kestrels by measuring fertility, eggshell thickness and morphology of the reproductive systems of both generations. Dicofol causes thinning in the eggshells of Ring Doves and this study is important to determine whether sensitive species such as falcons are proportionally at risk from dicofol as they are from DDE.

It is considered that this information will be valuable in the planned examiniation of the registration of dicofol by Environment Canada.

Funding:

The WTF approved a grant of $12,424 for this project. A portion of this contribution comes from funds allocated by Quebec Environment. Earlier support in the amount of $48,482 had been awarded by the WTF.

Matching Funds:

The Natural Sciences and Engineering Research Council and the University of California have provided matching funds for the project.

3. "Transfer of Metals from the Aquatic Environment to Wildlife"

Co-ordinator:

Dr. Harold H. Harvey
Dept. of Zoology
University of Toronto

Description:

The project is seeking to develop a better understanding of the factors that influence the availability of metals in lake sediments, benthos, and fishes to fur-bearing mammals. To date, the researchers have determined the concentration of 14 elements in chironomid larvae, emergent winged adults, two species of crayfish, a benthic feeding fish and fur-bearing mammals from four to five study lakes. As the physio-chemical conditions of the five study lakes are different, they have been able to assess the role of pH and sediment redox conditions on influencing metal availability to biota.

Because of the different physio-chemical conditions of the study lakes, two major geochemical controls can be identified: 1) reducing environments where metal availability is controlled by sulphide formation; and 2) oxidising environments where availability is controlled by absorption onto oxide surfaces. The researchers hope to confirm the presence of these two geochemical controls through the sequential extraction of the sediments of the five study lakes. The predominant ligands that the trace metals are associated with will be related to the known metal concentration in benthic insect larvae, emergent adults, crayfish, fish and mammals.

Funding:

The WTF approved a grant of $6,000 for the current phase of the project. Earlier support in the amount of $62,451 had been awarded by the WTF.

Matching Funds:

The Ontario Ministry of the Environment and the Ontario Ministry of Natural Resources provided the matching funds for the project.

4. "Vitamin A-Related Mechanisms of Dioxin Toxicity"

Co-ordinator:

Dr. Philip Spear
Dept. of Biology
University of Quebec

Description:

The polyhalogenated dibenzo-p-dioxins, dibenzofurans, certain biphenyls, and other similarly-acting contaminants are typically found as complex mixtures in the environment. The exact composition of these mixtures varies both geographically and temporally, besides being difficult and costly to measure. Dr. Spear's research has shown that these compounds elicit an array of effects upon the dynamics and metabolism of retinoids (vitamin A). Some of the changes in retinoid concentrations can be useful in sensitive, bio-effects monitoring for the "dioxin-like" contaminants. Having developed ways to monitor for the dioxin-like compounds, the next step is to understand how the effects are produced and the implications of such effects.

The work is exploring mechanisms responsible for the low vitamin A stores in adult birds and altered forms of vitamin A (retinoids) in the eggs of birds inhabiting the more highly contaminated areas of the Great Lakes. Controlled experiments with the Ring dove and Japanese quail conducted in conjunction with the environmental studies will confirm the actions of the dioxin-like compounds. Knowledge of the related mechanisms will facilitate the establishment of cause-effect relationships, allow predictions of effects arising from other contaminants having similar biochemical mechanisms, and help to identify possible interactions with disease including immunosuppression, and more severe effects such as embryo mortality and teratogenesis.

Funding:

The WTF approved a grant of $81,645 for this project.

Matching Funds:

The Natural Sciences and Engineering Research Council and the Max Bell Foundation provided matching funds for the project.

5. "Sub-Lethal Effects of Organophosphate Insecticides on Learning and Memory in Birds"

Co-ordinator:

Dr. Peter Boag
Dept. of Biology
Queen's University

Description:

Most of the chemical insecticides currently in use in Canadian agriculture and forestry are anti-cholinestrase agents. There is growing evidence that exposure of wildlife species to these agents is extensive and that, in some situations, mortality of exposed individuals is widespread. A key question in assessing the full impact of anti-cholinesterase insecticides on wildlife populations is whether sub-lethal exposure can affect the long term health, survival and reproductive potential of exposed individuals. Because sub-lethally dosed individuals eventually recover from gross symptoms of intoxication, and because others appear to still be functional despite drastically reduced cholinesterase levels, it has been argued that much of the sub-lethal exposure to anti-cholinesterase agents is without serious consequence to the exposed individuals.

The aim of the proposed research is to test this assumption and to investigate some of the possible consequences of sub-lethal exposure to these agents.

The test system used was the food-caching behaviour of Blackcapped Chickadees under captive conditions. Results to date indicate that memory retrieval in the test system may not be affected by realistic exposures to the model insecticide, fenitrothion. Further work is proposed to look at memory formation and/or consolidation as potential targets of anti-cholinesterase agents.

Funding:

The WTF approved a grant of $42,590 for this project.

Matching Funds:

Environment Canada, Health and Welfare Canada and Queen's University provided matching funds for the project.

6. "Effect of Lake Acidification and Cadmium on Avian Species"

Co-ordinator:

Dr. Jon C. Barlow
Department of Zoology
University of Toronto

Description:

Many studies have shown acid precipitation to be detrimental to ecosystem stability and cadmium to be toxic to certain organisms. However, little is known about the effects of acid rain and Cadmium on wild bird populations. The reproductive success of birds may be affected by acid rain as a consequence of either disrupted resource transfer (food quantity), or "toxicity" resulting from increased and/or insufficient levels of various trace elements (food quality). Dr. Barlow and his research team are examining the reproductive success of Tree Swallows nesting near experimentally acidified and reference lakes. At the same time, they are monitoring changes in abundance of chironomids emerging from the lakes as a result of lake acidification .

In addition, because Cadmium (at concentrations below present Canadian standards) may accumulate in the tissues of aquatic organisms which form the diet of certain birds species, it may also be transferred to, and accumulate to toxic levels in the birds themselves.

The Experimental Lakes Area in northwestern Ontario, a field station specializing in whole-lake manipulation experiments, was chosen to examine the extent of these responses and behaviour of selected bird species. In addition, trace element accumulation in the tissues of these birds in the vicinity of lakes which are either receiving Cadmium additions, or which have been experimentally acidified, will be assessed.

Funding:

The WTF approved a grant of $24,423 for this project.

Matching Funds:

The Natural Sciences and Engineering Research Council and the Ontario Ministry of Natural Resources provided matching funds for the project.

7. "Effect of Acidic Fogs on Trees"

Co-ordinator:

Dr. Tom Hutchinson
Institute of Environmental Studies
University of Toronto

Description:

Fog in mountainous regions and even at low altitudes has been found to be more acidic and with a greater concentration of ions than acid rain. The fog wets all leaf surfaces and is in contact with vegetation for long periods of time. As a result, acid fog presents a potentially serious stress to plants.

Dr. Hutchinson and his research team are trying to determine the effect of acid fogs on the foliage of key tree species, exhibiting dieback and decline in part of their range. Specifically, Dr. Hutchinson will: 1) determine whether leaves of trees neutralize acidic fogs and to what extent; 2) measure how much leaf surface deposits in situ contribute to the neutralization or acidification process; 3) determine whether acidic fog causes damage to leaf surfaces, particularly to the stomata; and 4) determine whether leaves collected in the field are deficient in key nutrients or have abnormal levels of heavy metals.

Funding:

The WTF approved a grant of $40,000 for this project.

Matching Funds:

The Natural Sciences and Engineering Research Council and the Canadian Forestry Service provided the matching funds for the project.

8. "Bioindicators of Sediment Bound Toxins"

Co-ordinator:

Dr. Mike Dickman
Dept. of Biological Sciences
Brock University

Description:

This project is exploring the use of chironomid labial plate deformities as indicators of the presence of mutagenic materials in river sediments.

Recently, the Ontario Ministry of Environment removed sediments contaminated with coal tars from the mouth of the Welland River. Through the research, Dr. Dickman hopes to determine whether the frequency of chiromonid labial plate deformities downstream of this site will decrease following this cleanup. This information will prove valuable to future cleanup operations. In addition, it may also help to establish a time scale for the recovery rate of benthic invertebrate populations following contaminated sediment removal.

Funding:

The WTF approved a grant of $8,000 for this project.

Matching Funds:

The Laidlaw Foundation provided the matching funds for the project.

9. "Effects of Acidic Precipitation on Waterfowl"

Co-ordinator:

Dr. Patrick Weatherhead
Dept. of Biology
Carleton University

Description:

The project is examining the effects of acid precipitation on waterfowl in northern Ontario. Specifically, Dr. Weatherhead hopes to identify whether waterfowl, particularly common Goldeneyes and Hooded Mergansers, experience differential breeding success on acid and non-acid wetlands. The project is considering specific ecological and behavioural mechanisms responsible for the observed breeding success, and how these mechanisms are affected by acid precipitation.

To date, the research has revealed that Goldeneyes and Hooded Mergansers consistently preferred to nest on fishless lakes over lakes with fish, but showed no preference for lakes of high or low pH. Goldeneyes did not initiate nests later or have significantly smaller clutches on pH wetlands, but late-nesting birds did have significantly greater variation in the size of eggs within their clutch than birds nesting on higher pH lakes. However hatching success was similar.

Using these results, the research team expects to find that female Goldeneyes assess acid and fishless wetlands as being of higher quality, due to higher invertebrate populations. They predict, however, that overall waterfowl productivity from acid wetlands may actually decline due to acid-related toxic effects. The research team hopes to identify particular wetland types at the greatest risk and those best suited for waterfowl production, providing valuable information for the creation of management steps for waterfowl protection and conservation.

Funding:

The WTF approved a grant of $28,000 for this project.

Matching Funds:

The Natural Sciences and Engineering Research Council, the Canadian Wildlife Service and Carleton University provided the matching funds for the project.

10. "Influence of Lake Acidification on Loons"

Co-ordinator:

Dr. Erica Dunn
Long Point Bird Observatory
Port Rowan, Ontario

Description:

Common Loons nesting on very acidified lakes in Ontario have reduced reproductive success. The Long Point Bird Observatory has undertaken studies with three objectives: 1) to determine whether the negative relationship between lake acidity and reduced breeding success on loons holds over a wider geographic area; 2) to learn the mechanisms by which acidity affects success; and 3) to assess the use of volunteer observers in a long-term monitoring program, using the Common Loon as an indicator of water quality in Ontario.

To date interim analyses show that 1) lower loon chick production in more acid sensitive lakes; and 2) greater parental feeding effort in conditions of low alkaline and higher aluminum concentrate. In November 1989, the volunteer loon survey became national in scope and known as the Canadian Lakes Loon Survey. This will increase information about the use of volunteers in a bio-monitoring program.

In general, this study is examining the effect of a pollutant on wildlife species, and evaluating the use of that species as an indicator of lake quality on a broad scale. It is also viewed as valuable in determining whether monitoring of loons can track the effectiveness of governmental guidelines on allowable emissions of sulphates.

Funding:

The WTF approved a grant of $67,346 for this project. This contribution comes from funds allocated by the Ontario Ministry of the Environment.

Matching Funds:

The Ontario Ministry of the Natural Resources, the Canadian Wildlife Service and Northern Reflections Ltd. provided the matching funds for this project.

11. "Effects of Acidic Precipitation on Waterfowl"

Co-ordinator:

Dr. Bill Freedman
Dept. of Biology
Dalhousie University

Description:

The fertilization of acidic lakes renders them eutrophic, and encourages a vigorous development of macrophytic and algal vegetation, benthic and planktonic invertebrates, waterfowl, and amphibious mammals. However, fertilization does not neutralize much of the acidity in such lakes, and there remain elevated concentrations of potentially toxic metals, particularly aluminum and mercury. Very little is known about the ecotoxicological hazards of metals in the invertebrate and plant foods of waterfowl that breed and/or feed on eutrophic acidic lakes, or for that matter on oligotrophic acidic lakes. However, it is reasonable to expect that metals ingested through the food web will accumulate in the body tissues of waterfowl feeding in acidic lakes.

Through this study, Dr. Freedman is measuring the seasonal concentrations of potentially toxic metals in the plant and invertebrate foods of ducks in one eutrophic and several oligotrophic lakes in Nova Scotia. Brood surveys are providing information on the importance of these lakes to waterfowl production. Collections and chemical analyses of feathers and body tissues of adult and young ducks are enabling the assessment of metal accumulation in the birds.

To date, the study reveals significantly higher median values for invertebrate abundance, macrophyte cover pH, alkalinity, turbidity, posphorous, dissolved organic compounds, nitrogens, silicates and chlorophyll for lakes that support breeding ducks than for those that do not.

Funding:

The WTF approved a grant of $44,375 for this project.

Matching Funds:

The Natural Sciences and Engineering Research Council and Environment Canada, Environment Canada and other miscellaneous government agencies provided the matching funds.

12. "Effects of Hexazinone Herbicides on Small Mammals"

Co-ordinator:

Mr. David Penner
Penner & Associates Ltd.
Edmonton, Alberta

Description:

The researcher conducted an intensive study on small mammals on comparable non-treated and herbicide-treated study areas over a four-year pre-treatment period on a vegetation-management research area. The researchers monitored small mammal population characteristics including abundance, survival, reproductive success, behaviour, and species composition to determine if any changes are treatment related. Samples of representative small mammal species were collected for tissues analysis of hexazinone residues to establish potential uptake, persistence, and possible consequences of the use of hexazinone herbicide on the food chain.

The study has now been completed and the findings reveal that acute toxic effects on small mammals ere not evident in the nine days following the application of hexazinone. Nor were any acute, sub-acute or chronic toxicity effects evident vis a vis the abundnace, survival and reproductive characteristics of small mammal populations during the winter of 1986-87 and during the three subsequent summer monitoring periods.

Funding:

The WTF approved a grant of $30,838 for this project. The WTF provided previous support for the project in the amount of $55,000.

Matching Funds:

The Canada/Alberta Forest Resource Development Agreement, Environment Canada and Supply and Services Canada provided matching funds for the project.

13. "Experimental Acidification of a Wetland Ecosystem"

Co-ordinator:

Dr. Suzanne A. Bayley
Department of Botany
University of Alberta

Description:

The research is seeking to determine the effects of simulated acidic deposition on a 3.5 hectare oligotrophic wetland that has been experimentally acidified for five years. Effects on ecosystem components — water chemistry, vegetation, amphibian, and insect fauna — are being assessed in an acidified portion of the mire and in an unacidified control portion that contains only lake water. The WTF is sponsoring that part of the project dealing with internal wetland impacts, while the Department of Fisheries and Oceans is funding those portions emphasizing downstream effects and effects on metals.

The water chemistry of the wetland pools has just started to change after five years of acidification and these changes are being documented. Initially high plant production values have gradually decreased in the last three years. Control and experimental productivity was equal in 1988. The research is seeking to determine whether production rates will continue to decline. Peat accumulation rates are also being documented. The effect of acid deposition on the ability of Sphagnum to retain and neutralize acid ions is being assessed, including changes in the base cation exchange capacity of the wetland. Experiments to assess the ability of amphibians to tolerate acid deposition will be made in experimental and control areas of the wetland.

Funding

The WTF is providing a grant of $70,000 for the project.

Matching Funds

The WTF contribution has been matched by funds from the Department of Fisheries and Oceans.

14. "Impact of B.t. on Chicks of Spruce Grouse, Non-target Insects, and Small Birds and Mammals"

Co-ordinator:

Dr. J.F. Bendell
Faculty of Forestry
University of Toronto

Description:

Bacillus thuringensis is a preferred pesticide in forestry to control larvae of pest Lepidoptera because of its narrow spectrum of activity and the lack of demonstrated impacts on non-target vertebrates, insects, and even some species of non-target Lepidoptera. However, work by Dr. Bendell et al. suggests that B.t. kills non-target Lepidoptera of the low shrub layer of plantations of Jack Pine and indirectly kills chicks of Spruce Grouse by reducing the abundance of caterpillars they require for food.

Part of the problem of measuring the impact of insecticides is that methods may be narrow and imprecise. One approach is to use insectivores sensitive to changes in the abundance of larval Lepidoptera and easily monitored as indicators.

As this is the case with chicks of Spruce Grouse, the research is undertaking studies to more rigorously test the effect of B.t on Spruce Grouse, insects of lower vegetation, and other birds, small mammals, and Amphibia that are in the forest used for work on grouse.

Funding

The WTF approved a grant of $14,450 for this project. This contribution comes from funds allocated by the Ontario Ministry of the Environment.

Matching Funds:

Matching funds for the project have been received from the Ontario Pesticides Advisory Council.

15. **"The Effects of Carbofuran on the Growth, Development and Thermoregulatory Ability of Mallard Ducklings"**

Co-ordinator:

Dr. Keith Solomon
Canadian Centre for Toxicology
Guelph, Ontario

Description:

The project is addressing the anti-cholinesterase pesticide, carbofuran, and its effects on mallard ducklings. In conjunction with research already carried out in the summer of 1988, the study is assessing the effects of sublethal carbofuran exposure upon the survival, growth, development, and thermoregulatory ability of mallard ducklings. Doses reflect those expected to be found in the wild.

Through the research, Dr. Solomon is determining the accumulation of carbofuran in potential aquatic duckling food sources, including invertebrates and floating macrophytes. He is also examining the interactive effects of sublethal carbofuran dosages with exposure to temperatures below the thermoneutral zone which might be encountered by wild ducklings in southern Manitoba. In addition, the duration of the depression of AChE activity in the plasma and brains of ducklings after a single carbofuran dosage is being determined. This will help to ascertain the period of greatest vulnerability to other environmental stressors.

Funding:

The WTF approved a grant of $5,500 for the research. Earlier support in the amount of $7,222 had been awarded by the WTF.

Matching Funds:

Matching funds have been secured from the Natural Sciences and Engineering Research Council and the Delta Waterfowl and Wetland Research Station.

16. "Effects of Environmental Exposure to Carbofuran and Mallard Ducks"

Co-ordinator:

Dr. Barrie Webster
Dept. of Soil Science
University of Manitoba

Description:

Carbofuran is sold for the control of various insect pests, particularly grasshoppers, in the Canadian prairie provinces. Treated fields and roadsides are often close to feeding and breeding areas of mallard ducks which evidently can ingest carbofuran via various routes, both environmental and dietary. In view of the great acute toxicity of this insecticide to birds, it is feared that the population of prairie mallard ducks may suffer significant harm as a result of this unintentional exposure. Further, sublethal behavioral aspects which are nevertheless relevant to duck population survival may also be affected; such effects may have been missed or ignored in earlier studies which focused on directly toxic (lethal) effects of carbofuran.

Through this project, mallard ducklings which are two to three days old are being exposed to grassland vegetation treated with carbofuran. Mortality, biological indicators of sublethality, and behavioural effects on the duckling will be followed in conjunction with detailed residue analysis for carbofuran and its major degradation products. Work to date indicates that the carbofuran residues available to ducklings through the application of liquid formulation Furadan for grasshopper control can affect some behaviour of mallard ducklings, this effect, however, appears to be dose related.

Work to date has indicated that the carbofuran residues available to ducklings through the application of liquid formulation Furadan for grasshopper control can affect some behaviour of mallard ducklings; however, this effect appears to be dose related.

Funding:

The WTF has approved a grant of $61,000 for this project.

Matching Funds:

Matching funds have been received from the Canadian Wildlife Service and Ducks Unlimited.

17. "Toxicology and Pathology of St. Lawrence Marine Mammals"

Co-ordinator:

Dr. Pierre Beland
St. Lawrence National Institute of Ecotoxicology
Rimouski, Quebec

Description:

From 60 to 80 cetaceans and pinnipeds are reported dead along the St. Lawrence Estuary and Gulf annually. With support from the WTF, as well as the Department of Fisheries and Oceans, Alcan Aluminum Ltd., Quebec Environment and the Quebec Wildlife Foundation, Dr. Pierre Beland and his team are collecting tissues from many of these carcasses to document health problems and various toxic compounds (organochlorines, PAHs and metals.) Beluga whales account for 20% to 30% of the marine mammal specimens found.

Results of this epidemological study have established the concurrence of particularly high levels of toxic chemicals in belugas along with a high incidence of various diseases, many of which are known to be induced by these compounds in experimental studies of other vertebrates. The comparison with other marine mammal species puts the beluga situation in proper perspective. Toxic compound levels appear to be related to diet and time of residence of each species in the system.

To date, organochlorine analyses on the bludder of ten species showed low to medium levels in all except belugas, with an inverse relationshp to species size; average levels in belugas were much higher. In male belugas, the researchers have detected a slight increase in DDT and a slight decrease in PCB levels over the period 1982-1989; no trends were found in females. Dr. Beland has also documented Beluga liver tissue as being highly contaminated with mercury, showing a significant increase with age; and that low levels of cadmium were present in this same tissue.

The number of deaths recorded in 1989 was slightly less than during the record year 1988 and there was no mass-mortality event. Moreover the distribution by species was the same as observed in 1983. Excluding Belugas, however, more than half of the deaths were due to human activities and the number of dead belugas was essentially the same as during the record year.

Funding:

The Wildlife Toxicology Fund is providing a grant of $75,000 for the project.

Matching Funds:

Matching funds have been received from the Department of Fisheries and Oceans, Alcan Aluminum Ltd., Greenpeace, the Quebec Wildlife Foundation and Quebec Environment.

18. "The Interaction of Dioxins, Predation and Colony Size in Affecting Breeding Success of Great Blue Herons"

Co-ordinator:

Dr. Kim Cheng
Dept. of Animal Science
University of British Columbia

Description:

In the 1989 breeding seasons, experiments and observations are being carried out to study the effects of poly-chlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) contamination, colony size, predation, and the interaction of these three factors on the reproductive success of the Great Blue Heron. Productivity of 12 Great Blue Heron colonies (varying in number of breeding pairs) nesting along the Strait of Georgia were monitored and PCDD and PCDF levels of eggs from these colonies were estimated. Evidence of predation by bald eagles and crows was examined. Four of the 12 colonies will be monitored intensively and frequency of predation, reaction of herons to predators, and the relationship between incubation behaviour and egg predation are being measured.

The project is being carried out as part of a co-ordinated effort to study the effects of environmental PCDDD and PCDF on wildlife species. The data collected will complement physiological data collected by other researchers at the Canadian Wildlife Service and the University of British Columbia.

Funding:

The WTF approved a grant of $16,300 for the project.

Matching Funds:

The grant has been matched by funds from Fletcher Challenge, the Canadian Wildlife Service, the Cowichan Valley Naturalists Society and the Science Council of British Columbia.

19. "Availability and Effect on Waterfowl of Spent Lead Shot in the Maritime Provinces"

Co-ordinator:

Dr. Francis Schwab
Dept. of Biology
Acadia University

Description:

Research in the United States has demonstrated that spent lead shot from waterfowl hunters' guns causes lead poisoning in waterfowl. Those studies are responsible for a United States Fish and Wildlife Service ban by 1991 on the use of lead shot to hunt waterfowl. There are virtually no data available in Canada with respect to the availability of lead shot and the effect that shot has on waterfowl.

In 1988, the Canadian Wildlife Service (Atlantic Region) initiated a project to determine the lead shot situation in the Maritime provinces. Following on that work, this project seeks to determine: 1) the volume of spent lead shot available to waterfowl in heavily hunted Maritime marshes; 2) the incidence of lead shot ingestion by Black Ducks and Ring-necked Ducks on selected wetlands; and 3) whether there is a lead poisoning problem in Maritime waterfowl populations.

Funding:

The WTF approved a grant of $33,600 for the project.

Matching Funds:

The grant has been matched by funds from the provincial governments of New Brunswick, P.E.I., and Nova Scotia, the Atlantic Veterinary College and the Canadian Wildlife Service.

20. "Effects of Toxaphene, Chlordane and Chlorinated Dibenzofurans on Hatching Success and Fry Survival of Lake Trout and White Suckers"

Co-ordinator:

Dr. Fred Ward
Dept. of Zoology
University of Manitoba

Description:

Recently there has been increasing concern over the amounts of contaminants such as toxaphene, chlordane and poly-chlorinated dibenzofurans in aquatic ecosystems and their effects on aquatic organisms. Although much is known about the acute toxicity of these contaminants, very little is known of the potential effects of the biomagnification of them on the population of organisms, in this case fish.

The study is examining the effects of high body burdens of toxaphene, chlordane and a pentachloro-dibenzofuran on reproductive success of white suckers and lake trout populations in Lake 260 at the Experimental Lakes area in northwestern Ontario. Adult fish are being exposed to the contaminant by an interperitoneal injection of one of the three toxicants on corn oil products. Residue analysis of parental fish and eggs will provide information on the amount of toxicant passed from parent to offspring. This information will be valuable in determining the current status of population and assessing the effect of contaminants on their reproductive potential.

Funding:

The WTF approved a grant of $40,000 for the project.

Matching Funds:

The grant has been matched by funds from the Natural Sciences and Engineering Research Council.

21. "Effects of Pyrethroid Pesticides on Early Development of Anuran Amphibians"

Co-ordinator:

Dr. Michael Berrill
Biology Department
Trent University

Description:

Pyrethroid pesticides are neurotoxins which eliminate insects with little apparent harm to birds or mammals. Fish are far more sensitive than mammals to pyrethroids, and the little data available indicate that frogs may be about as sensitive as fish. Frog and toad communities may be particularly susceptible to pyrethroid exposure as eggs and tadpoles. Further, rapidly developing stages such as gastrulae and late pre-metamorphosis tadpoles may be more sensitive than more slowly growing stages. In addition, fast growing species may be more sensitive than slow growing species, and since pyrethroids are more effective at colder temperatures, early spring breeders may be more affected than late spring and summer breeders.

Through the project, these predictions will be tested. Dr. Berrill is measuring hatching success and success at metamorphosis following exposure of eggs to the pyrethroid and is examining the extent of abnormal neuro-muscular development in both embryos and tadpoles.

Funding:

WTF has approved a grant of $40,000 for the project.

Matching Funds:

The grant has been matched by funds from the Natural Sciences and Engineering Research Council and Trent University.

22. "Toxicity of Trace Metals to Benthic Invertebrate Communities: A Field Experimental Study"

Co-ordinator:

Dr. Landis Hare
INRS-Eau
University of Quebec

Description:

Trace metals such as cadmium and lead are major contaminants in many Canadian lakes and are presumed to have toxic effects on aquatic organisms, especially those living in sediments where concentrations of these pollutants are highest. Laboratory experiments have shown trace metals to have toxic effects on benthic organisms. However, the effects of chronic exposure to environmentally realistic levels of trace elements under natural conditions remains largely unknown.

Through the research, Dr. Hare will measure in situ the toxic effects of Cd, Cu, Pb, and Zn by comparing the invertebrate communities colonizing treated and untreated sediments with respect to their species abundance, richness, diversity and life histories.

Funding:

The WTF approved a grant of $40,000 for the project.

Matching Funds:

The grant has been matched by funds from the Natural Sciences and Engineering Research Council.

23. "Biochemical Indicators of Environmental Stress Caused by Toxic Metals"

Co-ordinator:

Dr. Peter Campbell
INRS-Eau
University of Quebec

Description:

Trace metals of anthropogenic origin tend to accumulate in aquatic sediments, where they pose a potential danger to benthic organisms and their predators. Dr. Campbell and his research team are seeking to elucidate the metal detoxification mechanisms that are operative in benthic invertebrates living in contaminated environments, and to evaluate the potential use of molecules involved in metal detoxification as biochemical indicators of the physiological state of these organisms. The work proposed for the upcoming funding period involves an intensive study of the seasonal variation of metallothionein levels in *Andonta grandis*, coupled to transplant experiments from a relatively pristine lake to a contaminated lake.

Recommendations will be formulated with respect to the evaluation of metal stress on benthic organisms, and the prediction of changes in metal bioavailability that may result from man-induced perturbations such as acidification. The results will be of practical importance to those in public and private sectors who are concerned with the rational management of in situ contaminants and with the geochemical/biological consequences of the long range transport of airborne pollutants.

Funding:

The WTF has approved a grant of $45,000 for the project.

Matching Funds:

Matching funds have been received from the Natural Sciences Engineering and Research Council, INRS and FCAR.

24. "The Effects of Pulp Mill Effluent on Marine Bottom Fish and Bivalves"

Co-ordinator:

Dr. R. Reid
Dept. of Biology
University of Victoria

Description:

Recently, a ban has been placed on shellfish harvesting in areas within the Strait of Georgia, B.C. because of toxic environmental contamination from pulp mill effluent. Due to the variable nature of pulp effluent from one mill to the next, and the extreme complexity of estuarine and coastal ecosystems, few generalizations can be made concerning the environmental impact of these effluents on marine organisms.

With support from the WTF, Dr. Reid is conducting a survey of two pulp mills along the British Columbia coastline, monitoring benthic deposit-feeding bivalves and flatfish for histopathological and biochemical changes resulting from pulp mill effluent. Influences by differences in species, sex, and seasonal changes will also be monitored. Cellular and biochemical changes resulting from exposure to pollutants with respect to time will be examined through translocation experiments. Food-chain interaction will also be considered by feeding untreated flatfish with bivalves previously exposed to contaminate sediments.

Funding:

The WTF has approved a grant of $40,000 for the project.

Matching Funds:

The grant has been matched by funds from the Natural Sciences and Engineering Research Council.

25. "The Effects of Dioxin on the Developing Avian Nervous System"

Co-ordinator:

Dr. John Steeves
Dept. of Zoology
University of British Columbia

Description:

Polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs)and polychlorinated biphenyls (PCBs) are chemically related, stable, highly toxic, virtually ubiquitous environmental contaminants which have been measured in relatively high levels in the eggs of Great Blue Herons in several colonies in B.C. and in Washington state. The most contaminated B.C. heron colony that has been measured is near the Crofton pulp and paper mill. It failed to produce any fledglings in 1987 and 1988.

The project will determine the effects of dioxin on the developing avian nervous system. Although the indicator species is the Great Blue Heron, the researchers are initially using chicken embryos as the model species to fully characterize dioxin's effects. They will also determine if Great Blue Heron embryos contaminated in the wild in ovo with a mixture of dioxins and furans have a nervous system morphology comparable to that of dioxin-treated chicken embryos.

Funding:

The WTF has approved a grant of $39,900 for the project.

Matching Funds:

Matching funds have been received from the Canadian Wildlife Service and the B.C. Health Care Research Foundation.

26. "Hydrocarbon and Organochlorine Pollutants in Shorebirds and their Diet"

Co-ordinator:

Dr. C.C. Parrish
Canadian Institute of Fisheries Technology
Technical University of Nova Scotia

Description:

Minas Basin is an inlet of the Bay of Fundy which contains extensive mud flats. The Semipalmated Plover, the Semipalmated Sandpiper and other shorebirds feed heavily on benthic invertebrates in the Basin before migrating south for the winter. In building up large fat reserves, these birds create a repository for hydrophobic pollutants which may have entered the Bay of Fundy from the oil refinery located on its shores or via rivers which drain most of New Brunswick and part of Nova Scotia.

Dr. Parrish and his research team are measuring hydrocarbon and organochlorine pollutants (PAHs, PCBs, DDT and DDE) in Semipalmated Plovers and Sandpipers and their food collected from Minas Basin. The researchers are coupling these measurements with lipid class analyses and analyses for signature fatty acids to determine the relationships between pollutants and depot fats, and to elucidate food web connections. Shorebirds are being obtained from the Canadian Wildlife Service and two field trips will provide food samples. Lipids and hydrophobic pollutants are being measured on the gas chromatographs in the Marine Oils Laboratory of the Canadian Institute of Fisheries Technology.

Detailed analyses of hydrocarbon and organochlorine pollutant levels coupled with lipid class and fatty acid analyses will allow the researchers to establish the dietary conduit for hydrophobic pollutants from benthic invertebrates to Semipalmated Plovers and finally to Peregrine Falcons and their eggs. By establishing the major pathway, it will be possible to determine the critical step in this process. Thus measures can be taken to weaken the pollutant impact.

Funding:

The WTF has approved a one-time grant of $4,000.

Matching Funds:

Matching funds have been received from the International Association of Fish Meal Manufacturers.

27. "The Distribution and Prediction of Mercury in Freshwater Fish"

Co-ordinator:

Dr. Jacob Kalff
Dept. of Biology
McGill University

Description:

Elevated mercury concentrations in fish are common in North America and Europe and have resulted in restrictions on fish consumption by anglers and problems for native Canadians dependent on fish for part of their diet and culture. One major conclusion to be drawn from studies to date is the remarkable mercury variability encountered within and among fish species and environments in the northern hemisphere.

Dr. Kalff and his research team are seeking to establish a predictive model of mercury levels among and within fish species based on fish ecology and environmental characteristics. A large literature data set is being collected and analyzed for game fish species and their limnological environment in central and eastern Canada. Experimental work on three species is proposed to explain mechanisms underlying the literature derived patterns. The research will provide new insights into the pathways by which mercury enters the foodchain and will be useful in the future modeling of many organic contaminants that are as mercury lipophylic.

Funding:

The WTF has approved a grant of $31,250 for the project.

Matching Funds:

Matching funds have been secured from the Natural Sciences and Engineering Research Council.

28. "Acid Stress on the Physiology of Freshwater Clams"

Co-ordinator:

Dr. Brian R. McMahon
Department of Biosciences
University of Calgary

Description:

Bivalves are important and often dominant members of the freshwater benthic fauna. *Anodonta grandis simpsoniana* is a unionid bivalve found commonly in boreal lakes in north-central Alberta. Dr. McMahon and his colleagues are examining the effects of acid stress on the acid-base and ion regulatory mechanisms of this animal.

The specific objectives of the proposal are:

1. Determination of clam's acid tolerance.
2. Examination of change and compensation in acid-base state and extracellular ionic composition during and after sublethal acid exposure.
3. Investigation of the role of ion transport (Na, Cl, Ca, NH4 and tritratable alkalinity) in regulating internal pH.

The research is important given the vital significance of clams as a food source for vertebrates. The result may well be the incorporation of clams into an acidification model which will aid in the prediction and description of acid deposition effects.

Funding:

The WTF approved a two-year grant totalling $35,726.

Matching Funds:

The Natural Sciences and Engineering Research Council has provided matching funds for this project.

29. "Effects of Dioxin Contamination on Great Blue Herons"

Co-ordinator:

Dr. Gail D. Bellward
Faculty of Pharmaceutical Sciences
University of British Columbia

Description:

Dioxins and related compounds are environmental contaminants produced from the chlorine bleaching process used in many pulp mills, the burning of organic material at low temperatures, and during the manufacture of chlorinated organic compounds. Dioxins, especially 2,3,7,8-TCDD, are known to be potent chemicals in laboratory and domesticated animals, resulting in reproductive failure, inhibition of the immune system, promotion of cancer, and a wasting syndrome resulting in death. Because of their fat solubility and long half-lives, levels of these compounds have been building up in the environment over the years. Controversy presently exists as to whether these pollutants are toxic to wild animals or to humans at the levels found in Canada today.

Preliminary studies by the researchers support the hypothesis that the reproductive failure noted in a blue heron colony in B.C. is due to the toxic effects of the 2,3,7,8-TCDD, and indicates the potential for more serious effects at higher levels or longer periods of exposure. Due to the large number of variables present in field work, including changing dioxin levels, predators and human interference, the researchers are testing this hypothesis in the laboratory.

The researchers are conducting dose-response curves for 2,3,7,8-TCDD effects using great blue heron eggs from a relatively uncontaminated colony. The ED50 for various parameters is being determined, along with a study of lethality *in ovo*. In addition, a similar study to that previously carried out with herons is being conducted on cormorants. This species is also exhibiting reproductive problems. Preparatory to a major study on the effects of dioxins in adult herons, this preliminary study on growth and energetics of herons is being conducted.

Funding:

The WTF approved a two-year grant totalling $143,692.

Matching Funds:

The Natural Sciences and Engineering Research Council and CWS have provided the matching funds for this project.

30. *"New Technique for the Diagnosis of Death Due to Anti-Cholinesterase Poisoning"*

Co-ordinator:

Dr. F.A. Leighton
Department of Veterinary Pathology
University of Saskatchewan

Description:

The purpose of this research is to evaluate a new method for diagnosing poisoning by organophosphate and carbamate pesticides of animals found dead in the wild. The researchers are assessing the practical usefulness of parallel measurement of acetylcholinesterase (Ache) and cholinergic binding receptors (CBR) in diagnosing death due to these anti-cholinesterase pesticides.

The objective is to assess the reliability of CBR as an index to estimate the normal level of AChE and, hence, the degree of AChE depression due to intoxication. Previous studies indicate that CBR can predict normal AChE under conditions of *post mortem* decomposition and intoxication with an organophosphate in Japanese quail. Thus, CBR might replace the control specimens that currently are required, but usually are unavailable, when AChE alone is used as the diagnostic criterion for anti-cholinesterase poisoning. The research addresses the practical problem in the assessment of the effects of major agricultural and forestry chemicals on wildlife. Without a definitive diagnosis, mortality cannot be attributed to any cause. Thus, accurate diagnosis is an essential tool for evaluating lethal effects of organophosphate and carbamate insecticides on wildlife.

Funding:

The WTF has approved a two-year grant totalling $31,754.

Matching Funds:

The University of Saskatchewan and the Natural Sciences and Engineering Research Council have provided matching funds.

31. *"Geochemical Cycles of Trace Metals in Bogs and Fens"*

Co-ordinator:

Dr. Francis Pick & Dr. Leah Bendell Young
Department of Biology
University of Ottawa

Description

The overall objectives of this study are to determine the influence of wetland acidification on the geochemical cycles of trace metals and to ascertain if the anthropogenic perturbation of these cycles results in the increased accumulation of toxic metals, such as lead and cadmium by the associated biota.

Drs. Pick and Young propose to document the geochemical cycles of trace metals in three types of wetland. Specifically they will: determine the distribution of trace metals in surficial sediments of the three wetland types; determine concentrations of metals in the associated porewaters such that the contribution of within sediment processes to the geochemistry of the surficial sediments can be assessed; and will determine concentrations of metals in the overlying waters.

By determining the processes that influence metal availability to prey items, the researchers will establish which factors result in the increased accumulation and hence transfer of metals from wetlands to the terrestrial environment. The research will also shed light on what wetland factors maximize the foodchain transfer of toxic metals and to rank wetlands in order of their sensitivity to metal transfer.

Funding:

The WTF has approved funding for this project with a two-year grant totalling $68,136.

Matching Funds:

The Natural Sciences and Engineering Research Council and the Ontario Ministry of the Environment have provided matching funds.

32. "Prairie Pesticide Monitoring Program"

Co-ordinator:

Ms. Louise Horstman
Pecan Resources Inc.
Westlock, Alberta

Description

During outbreaks of crop pests, such as grasshoppers, armyworms, cutworm, wheat blossom midge and diamond-backed moth on the prairie provinces, up to 7 million hectares may be treated with insecticides. Several of the pesticides used are classified as priority pesticides by the Department of the Environment, including carbofuran, chlorpyrifos, azinphos-methyl and deltamethrin. The research undertaken here will enhance the knowledge regarding the risk posed to songbirds by various insecticide products.

With support from the WTF, Ms. Horstman is investigating the hazard of agricultural insecticides to songbirds on the western prairies and parklands. The research involves a well established and co-ordinated monitoring program utilizing existing, volunteer-run nestbox trails through selected agricultural areas. Volunteer trail operators are collecting data from nestboxes on mortality, hatching and fledging success and related external influences. Trails have been selected from areas where certain crops, namely canola, alfalfa seed, and wheat, which are routinely treated with insecticides, are grown. A minimum of 30 nestboxes occupied by Mountain Bluebirds and 30 occupied by Tree Swallows will be located adjacent to each of these crop types. For controls, a minimum of 30 boxes occupied by each species located next to untreated hay or pasture are being used.

Funding:

A two-year grant totalling $15,000 was approved for the project.

Matching Funds:

The Canadian Wildlife Service is providing matching funds.

33. "Biological Monitoring for Long-range Deposition of Airborne Contaminants in the High Arctic"

Co-ordinator:

Dr. Pamela Welbourn
Institute for Environmental Studies
University of Toronto

Description:

Meterological and precipitation analyses have indicated that the Canadian Arctic is exposed to the long-range transportation of air pollutants (LRTAP). Probably due in part to thermally depressed biological turnover rates and particulate condensation at low temperatures, measurable residues of anthropogenic contaminants have been found within biota inhabiting Arctic regions. Only rarely, however, has biological monitoring been conducted at latitudes exceeding 70 degrees North. An extensive literature exists demonstrating lichens to be very effective monitors of the cumulative deposition of a wide variety of airborne contaminants.

This study is taking advantage of the unique opportunity arising from the 1990 Arctic Light Expedition, a five month human-powered trek from the tip to the base of Ellesmere Island. Members of the expedition will collect up to 75 samples of lichen from 15 sites along a 1,200 km transect (83 to 76 N) on Ellesmere Island. This is the most northerly biomonitoring study ever undertaken. Samples are being analyzed for selected pesticides, radionuclides, trace metals, and sulphur concentrations. Such results will provide information on: 1) the extent of LRTAP to one of the most remote and "pristine" regions of the globe; and 2) the potential for food chain transfer and biomagnification of micropollutants to Arctic wildlife in Ellesmere Island, and to the Inuit hunters in Canada's northernmost permanent community.

Funding:

A one-year grant totalling $23,300 was approved.

Matching Funds:

The Natural Sciences and Engineering Research Council has provided matching funds.

34. "Effects of Carbofuran on Survival of Mallard Ducklings"

Co-ordinator:

Ms. Pamela A. Martin
Delta Waterfowl and Wetlands Research Station
Portage le Prairie, Manitoba

Description:

Duck nests are often located in remnants of habitat interspersed among cropland in the prairies; hence, the spraying of carbofuran for grasshopper control in particular can contaminant vegetation traversed by newly hatched ducklings. Spraying for grasshopper control takes place from early June to mid-July, which overlaps with the peak hatching period of mallard and pintail. Carbofuran is extremely toxic to waterfowl, and ducklings are probably more sensitive than are adults, due to their small size. In an earlier study, mallard ducklings exposed to carbofuran-contaminated vegetation in a simulated field situation exhibited signs of cholinesterase inhibition and decreased brood cohesiveness.

This project is examining the effects of exposure to upland vegetation sprayed with field levels of carbofuran, on mallard ducklings under natural field conditions. Mallard brood hens and their broods are being released into sprayed vegetation upland from pond enclosures. Overland movement is being monitored by heat-sensitive radios implanted in half of the ducklings of each brood. Survival of ducklings is being determined during one week following exposure and behavioral observations made during this time. Carbofuran, the pesticide marketed as Furadan, is currently undergoing re-evaluation in Canada because of the concerns of the Canadian Wildlife Service for its harmful impact on Burrowing Owls and the potential risk to breeding waterfowl. This study will be valuable in elucidating the effects of this chemical on waterfowl and in providing advice on its environmental impact for use in the re-evaluation process.

Funding:

A one-year grant totalling $20,000 has been approved.

Matching Funds:

The Canadian Wildlife Service and the Prairie Habitat Joint Venture have provided matching funds.

APPENDIX B

LIST OF WTF FINAL REPORTS

(Please indicate the reports you would like to receive and return to Margaret Chrumka, World Wildlife Fund Canada, Suite 201, 60 St. Clair Ave. East, Toronto, M4T 1N5.)

1. "Burdens of Ionic Alkylleads in Pigeons and Eels from Metropolitan Montreal and Environs", Dr. W.D. Marshall, Macdonald College, McGill University.

2. "Behavioral and Reproductive Correlates of Reduced Levels of Cholinesterase Activity in Zebra Finches Following Acute Exposure to Fenitrothion", Dr. Stephen B. Holmes and Dr. Peter Boag, Queen's University.

3. "The Effects of Aluminum on Amphibians", Dr. Joseph Freda and Dr. Gordon McDonald, McMaster University.

4. "Effects of Hexazinone on Small Mammal Populations", Mr. David Penner, Penner and Associates Ltd.

5. "Lipids and Hydrocarbons in Corophium volutator (Pallas) from Minas Basin, Nova Scotia", Dr. Robert Ackman, Dept. of Oceanography, Dalhousie University.

6. "The Pharmacological and Ecological Effects of Malathion Treatments on Juvenile Walleye", Dr. F.J. Ward, University of Manitoba.

7. "Experimental Acidification of a Freshwater Wetland", Dr. Suzanne Bayley, University of Manitoba.

8. "The Development of Retinoid Monitoring for Dioxins and Related Compounds", Dr. Thomas Moon and Dr. Philip Spear, University of Ottawa.

9. "A Toxicological Assessment of Peregrine Falcon Breeding in the Keewatin District of the Northwest Territories", Mr. Gordon Court, University of Alberta

Reports Received as of April 12th, 1989

10. "The Investigation Dynamics of Organic Contaminant Uptake by Natural Sesnon", Dr. R.H. Peters, McGill U.

11. "The Impacts of Sugar Maple Decline on Insectivorous Birds", Dr. Yves Mauffette, U. of Quebec at Montreal.

12. "Metal Accumulation by Larval Chironomids", G. Krantzberg and Dr. Pamela Welbourn, University of Toronto.

13. "Effects of Lake Acidification and Cadmium on Avian Species", Dr. J. Barlow, U. of Toronto.

14. "The Effect of PCP on Gammarus tigrinus", Dr. F. Baerlocher, Mount Alison University.

15. "Environmental Toxicology of the Welland River Wetland Area", Dr. Mike Dickman, Brock University.

Reports Received as of June 7th, 1989

16. "Metal Sequestration in Marine Bivalves of the NE Pacific", Dr. R. Reid, University of Victoria.

17. "Importance of the Benthic Invertebrate Infauna in Hg Cycling in Two Lakes Remote from Point-Source Pollution," Martine Allard and Dr. Pamela Welbourn, University of Toronto.

Reports Received as of July 28th, 1989

18. "The Impact of Strychnine on Burrowing Owls", Dr. Paul James, Museum of Natural History.

19. "Study of the Effects of Toxic Metal Pollutants on a Cellular System Pertinent to Aquatic Wildlife", Dr. Francine Denizeau, University of Quebec at Montreal.

20. "The Significance of Neoplasia in Wild Fish Populations", Dr. Tony Hayes, University of Guelph.

21. "Development of Models to Describe the Dynamics of Toxic Organic Chemicals in the Environment and Wildlife of the Great Lakes Basin", Dr. Don Mackay, University of Toronto.

22. "Winter Feeding Ecology of Gulls near Presqu'ile Provincial Park, Ontario", Dr. Erica Nol, Trent University.

Reports Received as of November 15th, 1989

23. "Biological Significance of Trace Metals in Sediments", Dr. A. Tessier, INRS-Eau, University of Quebec.

24. "Effects of Silvicultural Herbicide Use on the Breeding Birds of Regenerating Forest Clearcuts in Nova Scotia", David MacKinnon and Dr. Bill Freedman, Dalhousie University.

25. "Exposure Indicators for Metals Discharged by a Smelter", Dr. J. Klaverkamp, U. of Manitoba.

26. "Toxins in Rocky Mountain Forage Legumes: A Preliminary Assessment", Dr. M.A.M. Bell, University of Victoria.

Reports received as of March 20, 1990

27. "The Use of Epiphytic Lichens as Indicators of Tree Decline in Forested Ecosystems," Dr. Thomas C. Hutchinson, University of Toronto

28. "Impact of Airborne Chlorinated Hydrocarbons in Aquatic Ecosystems," Dr. Don McQueen, University of Waterloo

Reports received as of April 24, 1990

29. "The Transfer of Metals from the Aquatic Environment to Wildlife," Dr. Harold Harvey, University of Toronto

Reports received as of September 13, 1990

30. "Mercury Contamination in the Freshwater Mussell Elliptic complanata in Two Lakes of South-Central Ontario Not Contaminated by Point-Source Pollution," Martine Allard and Dr. Pamela Welbourn, U. of Toronto

31. "Toenail-clipping: A Simple Technique for Marking Individual Nidicolous Chicks," Dr. J. Barlow, U. of Toronto

32. "Accumulation of Metals by Invertebrates and Fish - Thesis," Dr. Leah Bendell Young, U. of Toronto

33. "Bioassays for the Toxicity of Petroleum Oils to Birds - Thesis," Catherine M. Coulliard, U. of Saskatchewan

34. "Levels of Organochlorines and PCB's in Fish-eating and Raptoral Birds in Manitoba," Dr. Ken De Smet, Man. Department of Natural Resources.

35. "The Impact of Sporadic Industrial Discharges on Selected Biota of a Provincially Significant Riverine Wetlands Community," Dr. Mike Dickman, Brock U.

36. "Quantitative Analysis of the Impact of Contaminated Sediments on Diatom Community Structure in the Welland River," Dr. Mike Dickman, Brock U.

37. "Toxins and Genotoxins in the River Sediments of the Niagara Peninsula as Reflected by Chironomid Diversity and Frequency of Labial Plate Deformities," Dr. Mike Dickman, Brock U.

38. "Small Mammals in Hexazinone-Treated Clearcuts in Mixedwood Forest Region of North-Central Alberta," David Penner, Penner and Associates Ltd.

39. "Toxicity and Effects of Carbofuran on the Growth, Development and Thermal Ability of Mallard Ducklings," Dr. Keith R. Soloman

40. "Dove Reproduction and Vitamin A Dynamics Between Adult Females and Eggs Following Exposure to 3,3',4,4' - Tetrachlorobiphenyl," Dr. P.A. Spear, U. of Ottawa

41. "An In situ Study of the Effects and Persistence of Bromoxynil in Prairie Wetlands," Dr. Rodger D. Titman, Macdonald College, McGill U.

42. "Fate of Carbofuran and its Effects on Macroinvertebrates in Prairie Ponds - Thesis," Mark Wayland, U. of Alberta.

43. "Hydrocarbon and Organochlorine Pollutants in Shorebirds and their Diet in the Bay of Fundy." Dr. C. Parrish, Technical University of Nova Scotia.

APPENDIX C

WTF RESEARCH ADVISORY BOARD MEMBERS

Dr. Donald A. Chant (Chairperson)
Ontario Waste Management Corp.

Dr. Donald Ecobichon
McGill University

Dr. Bill Freedman
Dalhousie University

Dr. David Peakall
Canadian Wildlife Service

Dr. Bruno Schiefer
University of Saskatchewan

Dr. Claude Thellen
Quebec Environment

Dr. Peter Wells
Canadian Wildlife Service

APPENDIX D

WTF - GRANT COMMITMENTS 1988/1991

		1988/1989	1989/1990	1990/1991
1.	Dr. S. Perry, U. of Ottawa The Metabolic Consequences of Environmental Acidification	$38,000	$35,200	-
2.	Dr. David Bird, McGill U. The Effects of Dicofol on Kestrels	$12,424	-	-
3.	Dr. H. Harvey, U. of Toronto Transfer of Metals from the Aquatic Environment to Wildlife	$6,000	-	
4.	Dr. Philip Spear, U. of Montreal at Que. Vitamin A: Related Mechanisms of Dioxin Toxicity	$19,995	$31,450	$30,200
5.	Dr. Peter Boag, Queen's U. Sub-lethal Effects of Organophosphate Insecticides on Learning and Memory in Birds	$22,840	$19,750	-
6.	Dr. J. Barlow, U. of Toronto The Effect of Lake Acidification and Cadmium on Avian Species	$12,464	$11,959	-
7.	Dr. T. Hutchinson, U. of Toronto The Effect of Acidic Fogs on Trees	$20,000	$20,000	-

		1988/1989	1989/1990	1990/1991
8.	Dr. Mike Dickman, Brock U. Bioindicators of Sediment Bound Toxins	$8,000		-
9.	Dr. P. Weatherhead, Carleton U. The Effects of Acidic Precipitation on Waterfowl	$13,500	$3,000	$11,500
10.	Dr. Erica Dunn, Long Point Bird Observatory Influence of Lake Acidification on Loons	$21,875	$22,181	$23,290
11.	Dr. Bill Freedman, Dalhousie U. Effects on Acidic Precipitation on Waterfowl	$22,400	$21,975	-
12.	Mr. David Penner, Penner & Associates Ltd. Effects of Hexazinone Herbicide on Small Mammals	$25,000	$30,838	-
13.	Dr. Suzanne Bayley, U. of Manitoba Experimental Acidification of a Wetland Ecosystem	-	$35,000	$35,000
14.	Dr. J.F. Bendell, U. of Toronto Impact of Bt on Chicks of Spruce Grouse, non-target insects and Small Birds and Mammals	-	$14,450	-
15.	Dr. Keith Solomon, U. of Guelph Effects of Carbofuran on Mallard Ducklings	$7,222	$5,500	-

		1988/1989	1989/1990	1990/1991
16.	Dr. B. Webster, U. of Manitoba Effects of Environmental Exposure to Carbofuran	-	$49,000	$12,000
17.	Dr. Pierre Beland St. Lawrence National Institute of Ecotoxicology Effects of Toxic Chemicals on St. Lawrence Marine Mammals	$25,000	$25,000	$25,000
18.	Dr. K. Cheng, U. of British Columbia Dioxins and Great Blue Herons	-	$16,300	-
19.	Dr. F. Schwab, Acadia U. Effects of Lead on Waterfowl	-	$33,600	-
20.	Dr. F. Ward, U. of Manitoba Effects of Toxaphene on Lake Trout	-	$20,000	$20,000
21.	Dr. M. Berrill, Trent U. Effects of Pyrethroid on Amphibians	-	$20,000	$20,000
22.	Dr. L. Hare, U. of Montreal at Que. Toxicity of Trace Metals to Benthic Invertebrates	-	$20,000	$20,000
23.	Dr. P. Campbell U. of Montreal at Que. Biochemical Indicators of Environmental Stress	-	$15,000	$30,000
24.	Dr. R. Reid, U. of Victoria Effects of Pulp Mill Effluent on Bottom Fish	-	$20,000	$20,000

		1988/1989	1989/1990	1990/1991
25.	Dr. John Steeves, U. of British Columbia Effects of Dioxin on the Developing Avian Nervous System	-	$21,750	$18,150
26.	Dr. C.C. Parrish Technical U. of Nova Scotia Hydrocarbon and Organochlorine Pollutants in Shorebirds and their diet	-	$4,000	-
27.	Dr. Jacob Kalff, McGill U. Distribution & Prediction of Mercury in Can. Freshwater Fish	-	$19,450	$11,800
28.	Dr. Brian McMahon, U. of Calgary Acid Stress on the Physiology of Freshwater Clams	-	$15,703	$20,023
29.	Dr. Gail Bellward U. of British Columbia Effects of Dioxin Contamination on Great Blue Heron	-	$88,092	$55,600
30.	Dr. F.A. Leighton U. of Sasktachewan New Techniques for the Diagnosis of Death Due to Anti-cholinesterase Poisoning		$15,502	$16,252
31.	Dr. Francis Pick U. of Ottawa Geochemical Cycles of Trace Metals in Bogs and Fens	-	$33,728	$34,408
32.	Ms. Louise Horstman Pecan Resources Inc. Prairie Pesticide Monitoring Program	-	$8,000	$7,000

		1988/1989	1989/1990	1990/1991
33.	Dr. Pamela Welbourn University of Toronto Biological Monitoring for Long-range Deposition of Airborne Contaminants in the High Arctic	-	$23,300	-
34.	Ms. Pamela Martin Delta Waterfowl and Wetland Research Station Effects of Carbofuran on Ducklings	-	$20,000	-
	TOTALS:	**$254,720**	**$719,728**	**$410,223**

GRAND TOTAL: $1,384,671

APPENDIX E

WTF FUNDING & MATCHING FUNDS

PROJECT	TOTAL BUDGET	WTF FUNDS	MATCHING FUNDS & SOURCE
1.	$149,200	$ 73,200	$ 56,000 - Ontario Ministry of Natural Resources $ 20,000 - NSERC
2.	$140,552	$ 60,906	$ 57,396 - U. of California $ 22,250 - NSERC
3.	$147,009	$ 68,451	$ 40,888 - Ontario Ministry of the Environment $ 37,670 - OMNR
4.	$159,645	$ 81,645	$ 15,000 - NSERC $ 63,000 - Max Bell Foundation
5.	$137,460	$ 42,590	$ 87,795 - Environment Canada $ 5,075 - Health & Welfare Canada $ 2,000 - Queen's University
6.	$ 51,657	$ 24,423	$ 21,234 - NSERC $ 6,000 - Ontario Ministry of Natural Resources
7.	$ 98,000	$ 40,000	$ 31,000 - NSERC $ 27,000 - Canadian Forestry Service
8.	$ 16,000	$ 8,000	$ 8,000 - Laidlaw Foundation
9.	$ 76,000	$ 28,000	$ 25,000 - NSERC $ 21,000 - Canadian Wildlife Service $ 2,000 - Carleton U.
10.	$134,846	$ 67,346	$ 30,000 - Canadian Wildlife Service $ 30,000 - Ontario Ministry of Natural Resources $ 7,500 - Northern Reflections Ltd.
11.	$120,745	$ 44,375	$ 12,700 - NSERC $ 20,000 - Environment Canada $ 43,670 - Misc. Goverment Agencies

PROJECT	TOTAL BUDGET	WTF FUNDS	MATCHING FUNDS & SOURCE
12.	$314,018	$ 85,838	$ 3,000 - Environment Canada $ 6,180 - Supply & Services Canada $219,000 - Canada/Alberta Forest Resource Development Agreement
13.	$316,240	$ 70,000	$246,240 - Department of Fisheries & Oceans
14.	$ 30,950	$ 14,450	$ 16,500 - Ontario Pesticide Advisory Committee
15.	$ 22,500	$ 5,500	$ 12,000 - NSERC $ 5,000 - Delta Waterfowl and Wetland Research Station
16.	$341,970	$ 61,000	$228,464 - Canadian Wildlife Service $ 52,506 - Ducks Unlimited
17.	$264,565	$ 75,000	$ 86,425 - Alcan Aluminum Ltd. $ 80,140 - Department of Fisheries & Oceans $ 10,000 - Quebec Wildlife Foundation $ 8,000 - Quebec Environment $ 5,000 - Greenpeace
18.	$ 47,800	$ 16,300	$ 11,000 - Canadian Wildlife Service $ 4,000 - Fletcher Challenge $ 2,500 - Cowichan Valley Naturalists Society $ 14,000 - Science Council of B.C.
19.	$ 65,160	$ 33,600	$ 20,200 - Martime Provincial Governments $ 10,810 - Canadian Wildlife Service $ 550 - Atlantic Veterinary College
20.	$ 86,324	$ 40,000	$ 46,324 - NSERC
21.	$ 75,000	$ 40,000	$ 30,000 - NSERC $ 5,000 - Trent U.
22.	$ 87,250	$ 40,000	$ 47,250 - NSERC
23.	$190,821	$ 45,000	$ 68,550 - NSERC $ 40,271 - FCAR $ 37,000 - INRS - Eau

PROJECT	TOTAL BUDGET	WTF FUNDS	MATCHING FUNDS & SOURCE
24.	$113,200	$ 40,000	$ 73,200 - Department of Fisheries & Oceans
25.	$ 78,170	$ 39,900	$ 21,750 - B.C. Health Care Research Fdn. $ 10,000 - CWS $ 6,520 - private donations
26.	$ 8,000	$ 4,000	$ 4,000 - International Association of Fish Meal Manufacturers
27.	$ 81,950	$ 31,250	$ 50,700 - NSERC
28.	$ 81,682	$ 35,726	$ 45,956 - NSERC
29.	$297,992	$143,692	$110,600 - NSERC $ 43,700 - Canadian Wildlife Serivce
30.	$ 53,606	$ 31,754	$ 10,602 - NSERC $ 11,250 - U. of Saskatchewan
31.	$102,458	$ 68,136	$ 25,000 - NSERC $ 9,322 - Ontario Ministry of the Environment
32.	$ 24,750	$ 15,000	$ 9,750 - Canadian Wildlife Service
33.	$ 46,600	$ 23,300	$ 23,300 - NSERC
34.	$ 72,030	$ 20,000	$ 22,030 - CWS $ 30,000 - Prairie Habitat Joint Venture
TOTAL:	$4,034,150	$1,518,382	$2,515,768

APPENDIX F

PROVINCIAL & INSTITUTIONAL BREAKDOWN

British Columbia - (3)	
University of British Columbia	3
University of Victoria	1
Alberta - (4)	
University of Alberta	1
University of Calgary	1
Penner & Associates	1
Pecan Resources Inc.	1
Saskatchewan - (1)	
University of Saskatchewan	1
Manitoba - (3)	
University of Manitoba	2
Delta Waterfowl & Wetlands Research Station	1
Ontario - (13)	
University of Ottawa	2
University of Toronto	5
Queen's University	1
Brock University	1
Carleton University	1
Trent University	1
Long Point Bird Observatory	1
Canadian Centre for Toxicology	1
Quebec - (6)	
Macdonald College	1
McGill University	1
University of Quebec	3
St. Lawrence National Institute of Ecotoxicology	1
Nova Scotia - (3)	
Dalhousie University	1
Acadia University	1
Technical University of Nova Scotia	1
Total # of projects funded -	34